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A CONTRIBUTION TO THE MICROSCOPIC STUDY OF PEN AND INK LINES

By MARSHALL D. EWELL

In the third edition of a work entitled "Bibliotics, or the Study of Documents," etc., by Dr. Persifer Frazer, the learned author has devoted an entire chapter (Chapter X) to the study of so-called serrations in ink and lead-pencil lines and has attempted to show that by means of these serrations the authorship of a disputed writing may be determined. The author in the chapter mentioned calls these serrations "provisionally, variations of nerve force," and states that "the fact of the existence of these peculiarities is unquestioned and the value of the observations where proofs of identity or non-identity are sought is unquestionable." For a full presentation of the author's views reference should be made to Chapter X of his work where a clear presentation of the theory profusely illustrated will be found.

The fact that the views of the author have, without, as it seems, any independent investigation, received a *quasi* indorsement from Drs. Wood, Mitchell, and Witmer, as appears from their letters published in the preface and body of the work, and also from Winslow in his recent work (1905) on "Applied Microscopy," page 139, together with the further fact that Dr. Frazer has in at least one case¹ attempted by this method to establish the authorship of a disputed writing, demands a careful investigation of the theory before it is allowed any weight in jeopardizing human life or liberty.

That numerous irregularities in the contour of lines traced on paper by a pen or pencil exist will not be denied. The grosser ones are apparent to the naked eye and may be due to inexperience of the writer or to an unstable condition of his nervous system, however caused.

A microscopic examination of ink and pencil lines will also dis-

¹ The State of New York *vs.* Kennedy, tried in the City of New York in 1901.

close the existence of more minute irregularities or "serrations," if one prefers that term; but that they have any significance or weight whatever in determining the authorship of a disputed writing is denied.

In order to settle this question the writer made a series of observations early in the present year which seem to him to bear directly upon this question and to show that the claim has no reasonable grounds to warrant its acceptance. The process of exclusion of the various factors involved was the method of research adopted. Granted the existence of the so-called serrations, what is their cause? That they have in written characters any regularity of sequence is denied, and in the writer's judgment such regularity is not capable of proof. In the use of a diamond tool in ruling micrometers on glass or metal, or in turning metal in a lathe with a metal tool, if the tool is not properly held or ground, it frequently happens that it will chatter and produce regular serrations upon the glass or metal surface upon which the work is performed. These serrations may have rounded extremities or may be sharp and regular like saw-teeth; or the surface may be irregularly cut or torn. Let anyone who is the possessor of an Abbé test-plate examine it and he will have a good example.

A microscopical examination of the engine-ruled lines on writing paper will also disclose these so-called serrations in great numbers.

In the investigation of the question the writer first ruled lines on paper with a pen and ink by means of a dividing engine drawing the ruling carriage by a string in order to cut off any personal nervous influence. The lines so drawn uniformly exhibited serrations. The writer had years previously ruled lines on glass and through metal films on glass and knew from experience thus gained that serrations might be produced by a ruling tool improperly mounted; but that if the tool was properly held, a line could be produced that showed not the slightest irregularity of contour under a power of 1500 diameters.

The next step in the investigation was to write with a pen not charged with ink on a thin film on glass in the same manner that ordinary writing is produced, the only difference being that the lines were not produced on paper by ink. Some experiments were necessary in order to produce a film that would exactly record the movements of the pen perpendicular to and across the surface oper-

ated upon. Plate glass was held over a smoky flame and a very thin film of carbon thereby deposited upon its surface. This made a good medium for recording the action of the pen. The film must, however, be *very* thin, as otherwise the carbon will gather on the point of the pen and the accumulation will be deposited irregularly along the edges of the line much as a snow plough deposits the snow along the sides of the track, the difference being principally one of degree. Another film was produced by flowing the glass with a thin solution of wax and asphaltum in benzole. If too thick a film is used the same phenomenon of the deposition of the substance of the film along the edges of the line will be manifested. Satisfactory films having finally been made, thin enough to record the pen movements, they were written upon by various persons under the writer's direction with an ordinary dry steel pen held and operated in the usual manner, and in every instance the margins of the lines under a power of over one hundred and twenty diameters were absolutely clear, sharp and free from serrations of any sort. The ordinary writing of the same persons on paper with pen and ink had previously shown abundant serrations.

A microscopic examination of ordinary writing paper will uniformly show irregularities of surface, consisting of furrows, pits, and elevations. This fact was ascertained by a microscopical examination of the surface of the paper held at right angles to the optic axis of the microscope and from the examination of sections of the paper, the surface being parallel to the optic axis. These pits, furrows, and elevations afford an ample reason for the existence of the serrations in question, and the experiments above recorded show that they are not due to variations in the nerve force of the writer, but to irregularities in the surface of the paper itself.